

TECHNICAL REPORT – COVER PAGE

BRD Ref. No.: 1531

To: The Israeli – United States Binational Industrial Research and Development Foundation

Project Title: Blue Sky Sense and Avoid for MALE UAS

Submitted By:

Israeli Company: IAI

U.S. Company: Honeywell

Type of Report: Interim, Final: Interim

Project Start Date: January 1st, 2017

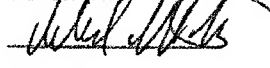
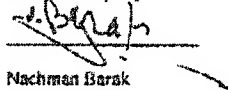
Dates of Reporting Segment Covered: from Jan 17th, 2017 to July 17th, 2017

Project Manager:

Israeli Company

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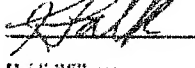
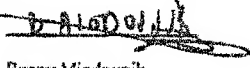
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1.0 OBJECTIVES

1.1 Project Objectives

The objective of this project is to demonstrate Sense and Avoid (SAA) capabilities for Unmanned Air Vehicles (UAV) using IAI's Heron UAV and Honeywell's prototype SAA equipment. The intended function is for the SAA equipment to detect both cooperative and non-cooperative intruders using signals from Traffic Collision Avoidance System (TCAS), Automatic Dependent Surveillance – Broadcast (ADS-B), and surveillance radar equipment. The UAV will then perform the appropriate guidance maneuvers based on integrated target track information from the SAA equipment and pilot input.

Demonstration of this capability will help to mature technology to eventually allow safe UAV operation in civil airspace.

1.2 Work Performed During Segment

During the work segment, from January 17th, 2017 through July 17th, 2017 the following work was performed:

Program plan prepared and baselined
Joint IAI and Honeywell program launch
SAA system & architecture definition complete
Heron installation preliminary design complete
Joint Technical Interchange Meeting/Preliminary Design Review

2.0 SUMMARY OF ACCOMPLISHMENTS

During the work segment, from January 17th, 2017 through July 17th, 2017 the following work was performed:

Program plan prepared, baselined, and monitored

- Development of schedule, spend plan, and manpower plans covering the two year period of performance
- Monthly status of program plan, and report out to internal management

Joint IAI and Honeywell program launch

- Conducted on March 27th and 28th, 2017 in Tel Aviv
- Topics covered included project team organization and leadership, organizational roles and responsibilities, work scope, technical assistance agreement overview, communication plan, system architecture, milestones, deliverables, and risks

SAA system definition complete

- System Specification prepared by Honeywell and delivered to IAI, including definition of mechanical interfaces, electrical interfaces, data interfaces, and installation guidance for Honeywell's SAA equipment suite.

Heron installation definition design complete

- Line replaceable unit installation

- DAA and transponder Antennas installation
- Radar installation- partially
- Harness design- partially (with the exception of the radar)

Joint Technical Interchange Meeting

- Conducted on July 18th and 19th in Redmond, Washington
- Topics covered included system architecture, interfaces, installation design

3.0 RESULTS

3.1 IAI Results

Task Name	Subtasks	Results	Variance to Program Plan
Task 1: System & HW Interface/Architecture Design	Functionality Defined (System Description)	Received and reviewed	None
	TPA-100(DAA) and transponder Hardware	mechanical and electrical preliminary design reviewed	None
	Interface Definition for DAPA (Mech, Elec, Data)	Received interim data. Performed initial mechanical installation review. Final definition scheduled for October	None
	Develop of Initial basic test scenarios for alerts and avoid maneuvers	Initial scenarios were developed and submitted to HON for review On-going process	None
	Initial procurement	Not started	Delayed since the detail design will take place on second segment of 2017 No impact on overhaul program
	Hardware detail design	Not started	Delayed start in Second Segment no impact on program
	Definition of all the control and data interface (airborne& ground)	Completed	None
Task 2: UAV&UCS S/W Development		In process	Start on July, no impact to program plan otherwise

Task Name	Subtasks	Results	Variance to Program Plan
Task 3: SIL integration and Test	No tasks planned for work segment	Complete	
Task 4: UAV Mechanical & Electrical installation	No tasks planned for work segment		
Task 5: Field Test, Flight Test. Post flight analysis	No tasks planned for work segment		
Task 6: Project Management	Project launch	completed	None

3.2 Honeywell Results

Following is a status of the Honeywell tasks that were planned for the work segment January 17th through July 17th, 2017:

Task Name	Subtasks	Results	Variance to Program Plan
Task 1: Interface and Architecture Definition	Functionality Defined (System Description)	Complete	None
	Flight Test Architecture Defined (System Description)	Complete	None
	Interface Definition for TPA (Mech, Elec, Data)	Complete	None
	Interface Definition for DAPA (Mech, Elec, Data)	In process, schedule for August completion	None
	Test Plan Development	In process, schedule for August completion	None
	TPA-100 Hardware Defined	Complete	None
Task 2: HW and SW Modifications	Sensor Fusion	Complete	None
	System Self Tests (TPA/Radar/System) - "Push Button Test"	Not started	Delayed start to July, no impact to program plan otherwise
	TPA interface SW mods	Not started	Delayed start to July, no impact to program plan otherwise
	Radar interface SW mods	Not started	Delayed start to July, no impact to program plan otherwise

Task Name	Subtasks	Results	Variance to Program Plan
Task 3: Development and System Tests	TPA/Transponder Interface Test	Complete	Yes this was performed earlier than planned due to the availability of personnel.
Task 4: Heron Installation and Flight Test	No tasks planned for work segment		
Task 5: Project Management	Project launch	Complete	None

No Program Plan tasks were added or deleted during this reporting period.

4.0 PLANS FOR NEXT PROJECT SEGMENT

4.1 IAI Plans for Next Segment

Task Name	Subtasks	Variance to Program Plan
Task 1: Interface and Architecture Definition	Complete DAPA Interface Definition	None
Task 2: UAV&UCS S/W Development	H/W UAV mechanical and electrical detail design	None
	TIM# 1 – performed on July 18-19	None
	H/W procurement for SIL and UAV	None
	Develop of DAA alerts algorithm and implementation in accordance with the MOPS	None
	IAI & HON development of "scenarios" with "truth data" and simulator data	None
Task 3: SIL integration and Test		None
Task 4: UAV Mechanical & Electrical installation		None
Task 5 Field Test, Flight Test. Post flight analysis		
Task 6: Project Management	On-going project tracking	None

4.2 Honeywell Plans for Next Segment

Honeywell's planned work for the next segment is shown in the following table. Currently there are no plans to terminate or re-direct any of these planned tasks.

Task Name	Subtasks	Variance to Program Plan
Task 1: Interface and Architecture Definition	Complete DAPA Interface Definition	None
	Complete Test Plan Development	None
Task 2: HW and SW Modifications	Complete System Self Tests (TPA/ Radar/ System) - "Push Button Test"	None
	Continue TPA interface SW mods	None
	Continue Radar interface SW mods	None
	TPA-100 Build and Test	None
	Order and Receive Transponder	None
Task 3: Development and System Tests	No tasks planned for the next work segment	None
Task 4: Heron Installation and Flight Test	General support of IAI installation questions	None
Task 5: Project Management	On-going project tracking	None

5.0 GRAPHICAL COMPARISON OF ACTUAL/PLANNED ACTIVITIES VS PROGRAM PLAN

5.1 IAI Actual vs Planned Activities

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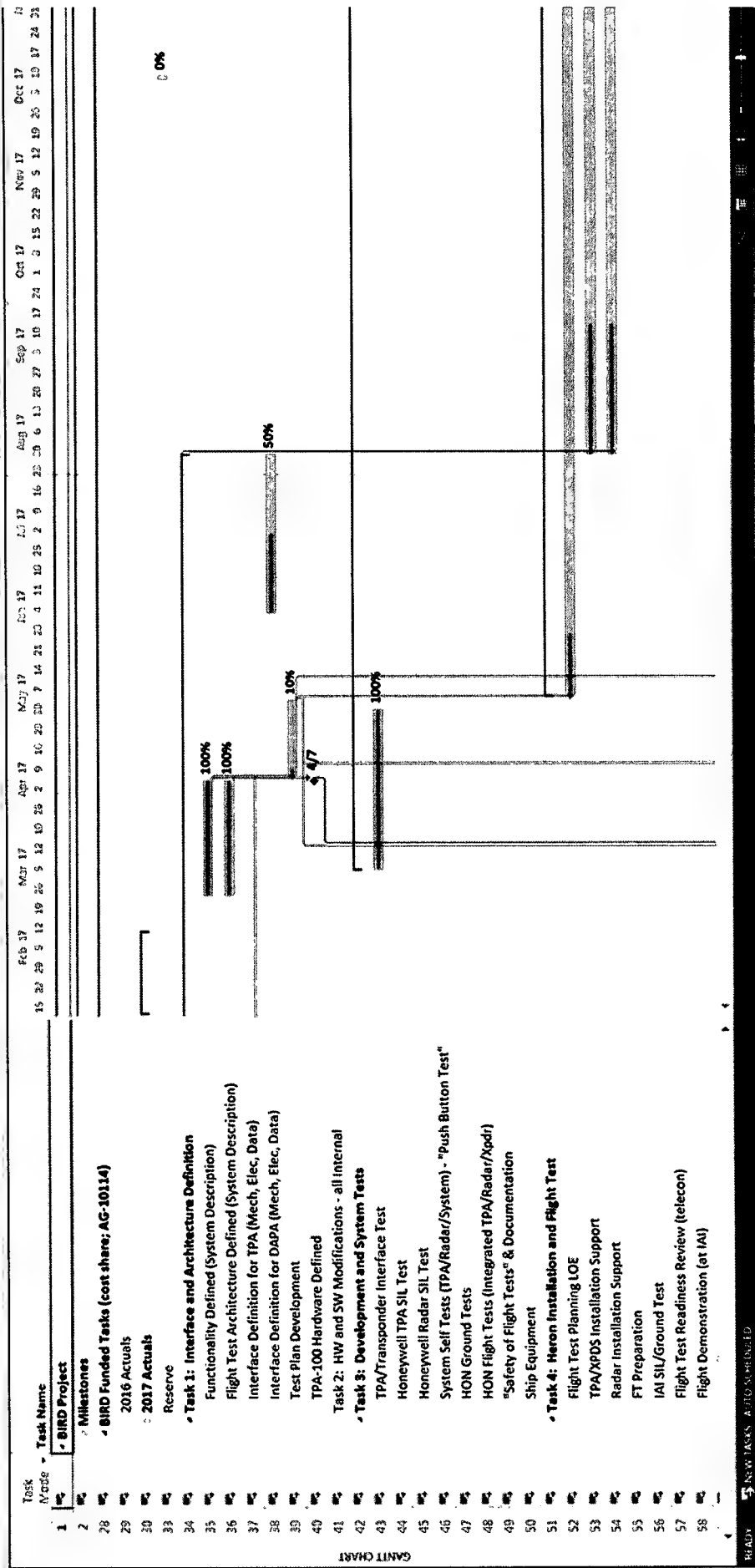
A snapshot of the IAI/MALAT Microsoft Project schedule is shown in the pages that follow, for the prior and next work segments. Percent completes are shown for each task. The schedule has not been re-baselined, other than to adjust for the project start date, thus there are no significant variances to discuss.

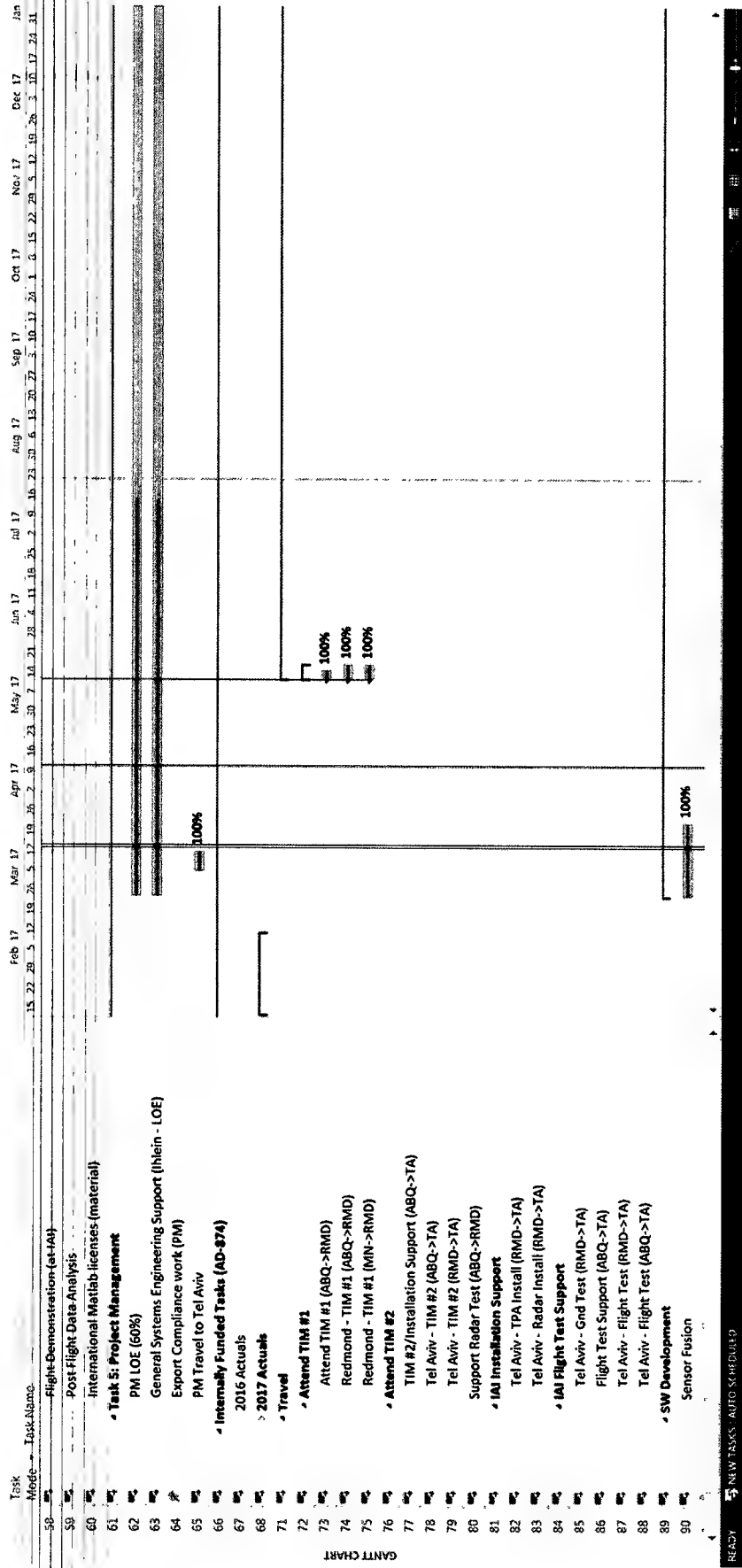
מזהה	שם	2017	2018	דצמב' 18	אוקט' 18	ספט' 18	אוג' 18	יולי 18	יוני 18	מאי 18	אפר' 18	מרץ 18	פבר' 18	ינו' 18	דצמב' 17
33	Export Compliance														
34	Final Report														
35	Task #1: System & HW Interface/ Architecture Design														
36	Mechanical Requirements Analysis														
37	TCAS & Transponder														
38	RADAR														
39	Electrical Requirements Analysis														
40	TCAS & Transponder														
41	RADAR														
42	UAV System Requirements Analysis														
43	UCS System SW Requirements Analysis														
44	Internal SRR														
45	Mechanical installation design														
46	Electrical installation design														
47	P-P Design														
48	Electrical Design														
49	Mechanical equipment purchase														
50	Electrical equipment manufacture and purchase														
51	Additional equipment purchase														
52	Task#2: UAV & UCS SW Development														
53	SYS Requirements definition														
54	SW Requirements definition														
55	Algorithms definitions														
56	Avoidance Algorithm definition														
57	Threat level definition														
58	Scenarios definition														
59	Threat Scenario Simulator development														
60	Simulator Requirements definitions														
61	DAA ICD definition														
62	Simulator SW Coding														
63	Simulator Integration														
64	Scenarios Validation														
65	UAV SW development														

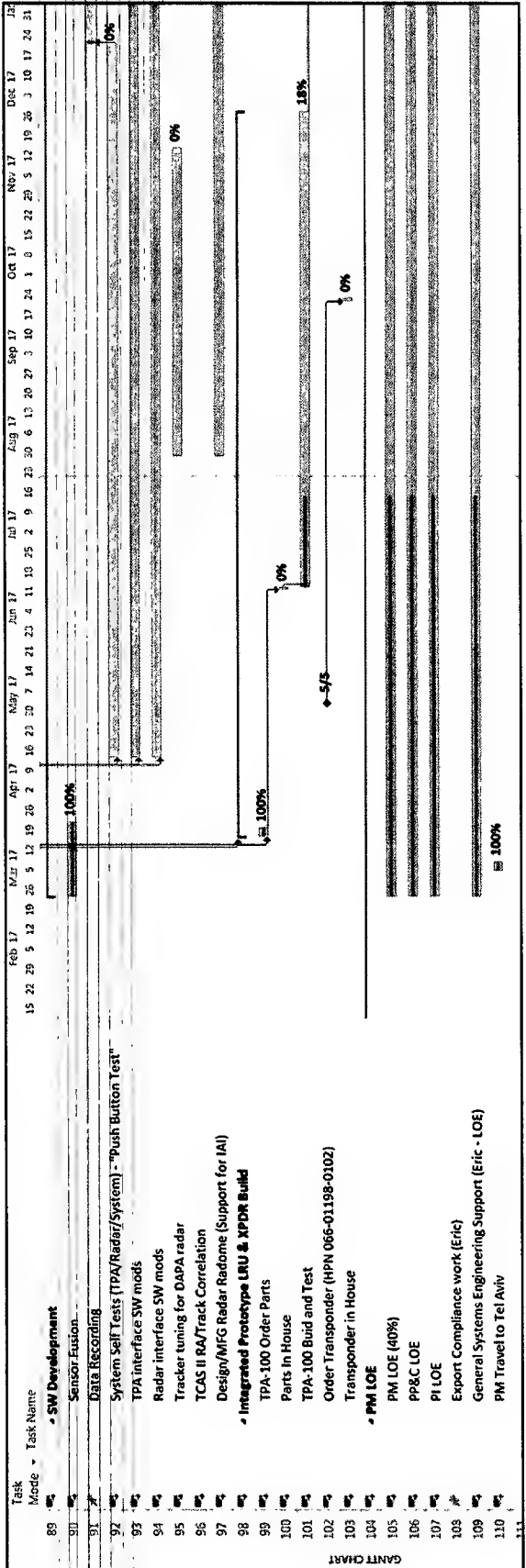
מזהה	שם	2017	2018	דצמבר	ינואר	פברואר	מרץ	אפריל	מאי	יוני	יולי	אוגוסט	ספטמבר	אוקטובר	נובמבר	דצמבר
66	UAV Software definitions															
67	UAV Software coding															
68	VDE Software definitions															
69	VDE Software coding															
70	UCS SW development															
71	UCS GUI update definitions															
72	UCS System Definitions															
73	UCS Software coding															
74	Task #3: SIL Integration & Tests															
75	SIL infrastructure definitions															
76	SIL equipment purchase															
77	SIL SW development															
78	SIL Build Up															
79	UAV Software integration															
80	SIL Simulated System Integration															
81	Buffer															
82	SIL TCAS, Transponder & Radar HW integration															
83	Task #4: UAV Mechanical & Electrical Installations															
84	UAV Mechanical installations															
85	UAV Electrical installations															
86	UAV Hangar Integrations															
87	Task #5: Field Tests and Test Flights															
88	UAV Shipment to Field (En-Shemer)															
89	Field integration															
90	EMI/RFI test															
91	CCA approval															
92	Intruder Aircraft															
93	Intruder Aircraft Requirements definition															
94	Intruder Aircraft Rental order															
95	Flight tests															
96	Demonstration															
97	Data Analysis															
98	Project Management															

5.2 Honeywell Actual vs Planned Activities

A snapshot of the Honeywell Microsoft Project schedule is shown in the pages that follow, for the prior and next work segments. Percent completes are shown for each task. The schedule has not been re-baselined, other than to adjust for the project start date, thus there are no significant variances to discuss.







6.0 COOPERATION BETWEEN COMPANIES

IAI and Honeywell conduct weekly communication telecons, and maintain an action register to track closure of action items. These telecons are attended by each company's project leadership, and subject matter experts are drawn in as required.

In addition, two face-to-face meetings have occurred, as follows:

Project Launch

Date: March 27-28th, 2017

Location: IAI's facility in Tel Aviv

Attendees: IAI Program Manager, Sales Manager, and Project Engineer; Honeywell Program Manager and Sales Manager

Technical Interchange Meeting #1/Preliminary Design Review

Date: July 18-19th, 2017

Location: Honeywell's facility in Redmond, Washington

Attendees: IAI Program Manager and Project Engineer; Honeywell Program Manager, Project Engineer, System Engineer, Data Fusion Expert, Software Developers, and Sales Manager

The working relationship between IAI and Honeywell is excellent, and each company's role in the project is well understood and mutually agreed upon.

7.0 RISK ANALYSIS

Proposal Risk Assessment -- The risk assessment from the proposal is as follows:

Risk #	Name	Ranking	Duration	Budget	Commercialization Potential
1	Compatibility to evolving standards	Low	High	High	High
2	Performance and safety – reaching the required accuracy, range, etc.	Medium	Medium	Medium	Low
3	Installations – size limitations, antennas, RF	High	Low	Low	Low
4	Program risks	Low	Medium	Low	Low
5	Client acceptance	Low	Low	Low	High
6	Honeywell Radar availability	Medium	Low	Medium	Medium

Risk #	Description	Type
1	<u>Compatibility to evolving standards</u> The regulation is still not defined. Ongoing efforts to define the standard in various working groups. Potential incompatibility of SAA specifications developed in this program. However, IAI and Honeywell will both be participating in the rule making process and therefore have a substantial advantage in accommodating changes in the recommended standards.	E
2	<u>Performance and safety – reaching the required accuracy, range, etc.</u> The algorithms and fusion and sensors input may not perform according to the desired specifications. However, both Honeywell and IAI have major technological heritage in relevant areas. We believe that all these challenges can be met.	T
3	<u>Installations – size limitations, antennas, RF</u> Accommodating sensors and equipment on board the Heron UAV may be risky due to RF compatibility; weight and size of the equipment; cabling; radome; etc. IAI has rich experience in installing various equipment on board the Heron. We assume we can find an optimal engineering solution.	T
4	<u>Program risks</u> Tasks may take longer than planned due to various reasons, or require additional resources.	M
5	<u>Market acceptance</u> Even if regulatory standards are met, each country may decide to allow or not to allow UAV's to fly in civilian airspace.	E

	Need to gain Trust within the general aviation community, air traffic management and safety authority.	
6	<u>DAPA Radar</u> Honeywell recognized the need for a non-cooperative SAA radar sensor and has been developing the technology for approximately 2 years. We would assess the TRL at 4. We have several technical “challenges” that Honeywell would like to see achieved before committing to project demonstration and commercialization. There will be a decision in late 2017 to determine whether to move forward with the planned DAPA radar or mitigate the risk with an alternative radar.	T

Updated Risk Assessment -- The current risk assessment is as follows:

Risk #	Name	Ranking	Duration	Budget	Commercialization Potential
1	Compatibility to evolving standards	Low	High	High	High
2	Performance and safety – reaching the required accuracy, range, etc.	Medium	Medium	Medium	Low
3	Installations – size imitations, antennas, RF	High	Low	Low	Low → High
4	Program risks	Low	Medium	Low	Low
5	Client acceptance	Low	Low	Low	High
6	Honeywell Radar availability	Medium → High	Low	Medium	Medium
7	<u>New Risk:</u> Flight test for collision may be changed or cancelled by CAA due to safety consideration	Low	Low	Low	Low

Risk #	Description	Type
1	<u>Compatibility to evolving standards</u> The regulation is still not defined. Ongoing efforts to define the standard in various working groups. Potential incompatibility of SAA specifications developed in this program. However, IAI and Honeywell will both be participating in the rule making process and therefore have a substantial advantage in accommodating changes in the recommended standards.	E

	<u>Update for this reporting period</u> – No change.	
2	<p><u>Performance and safety – reaching the required accuracy, range, etc.</u> The algorithms and fusion and sensors input may not perform according to the desired specifications. However, both Honeywell and IAI have major technological heritage in relevant areas. We believe that all these challenges can be met.</p> <p><u>Update for this reporting period</u> – The sensor fusion algorithms continue to mature through updates derived from data analysis obtained from the ongoing flight tests. Non cooperative sensor performance (DAPA Radar) is still TBD as the unit is still in development.</p>	T
3	<p><u>Installations – size limitations, antennas, RF</u> Accommodating sensors and equipment on board the Heron UAV may be risky due to RF compatibility; weight and size of the equipment; cabling; radome; etc. IAI has rich experience in installing various equipment on board the Heron. We assume we can find an optimal engineering solution.</p> <p><u>Update for this reporting period</u> – Antenna installation, as discussed in the July TIM, for the system demonstration is not optimal. There is Honeywell concern that this non-optimal installation will affect system performance and accuracy in a negative manner, making a true assessment of the system performance/potential difficult. Additionally, the subject of antenna placement for a commercialized version will need to be revisited at a later date, therefore the commercialization risk has been changed to high.</p>	T
4	<p><u>Program risks</u> Tasks may take longer than planned due to various reasons, or require additional resources.</p> <p><u>Update for this reporting period</u> – No change, to date all milestones have come in on target.</p>	M
5	<p><u>Market acceptance</u> Even if regulatory standards are met, each country may decide to allow or not to allow UAV's to fly in civilian airspace. Need to gain Trust within the general aviation community, air traffic management and safety authority.</p> <p><u>Update for this reporting period</u> – No change.</p>	E
6	<p><u>DAPA Radar</u> Honeywell recognized the need for a non-cooperative SAA radar sensor and has been developing the technology for approximately 2 years. We would assess the TRL at 4. We have several technical “challenges” that Honeywell would like to see achieved before committing to project demonstration and commercialization. There will be a decision in late 2017 to determine whether to move forward with the planned DAPA radar or mitigate the risk with an alternative radar.</p> <p><u>Update for this reporting period</u> – Honeywell is still working through the technical/schedule/budgetary challenges of developing the non-cooperative sensor, therefore the ranking has been changed to high.</p>	T

	<p>Risk mitigating activities include:</p> <ul style="list-style-type: none"> • IAI has a marine radar that could be potentially substituted as a risk mitigator. The technical specs for this radar will be examined during the current reporting period. • Rather than wait for all prototype equipment to be available for integration, IAI will start integrating the TCAS and ADS-B functions earlier than planned. This is will to mitigate the risk of flight test moving to 2019 should the DAPA radar availability be delayed. 	
7	<p><u>Flight test – New Risk</u> CAA may cancel flight plan if they consider that this scenario may cause a serious risk of collision. The risk mitigation plan will include:</p> <ul style="list-style-type: none"> • Perform flight over unpopulated areas such as sea. • The intruder air vehicle will be manned. • Perform the flight scenario within safety distances whereas simulation will be in accordance with the regulation 	T

8.0 MARKET AND COMMERCIALIZATION PLANS

Changes to neither the market nor the commercialization plan have occurred over the reporting period.

9.0 PUBLISHED MATERIAL

Neither IAI nor Honeywell have published any material or filed for any patents during the reporting period.